viti-notes

[understanding grapevine growth]

Research*to*Practice

Berry development – Ripening (Phase 3)

Viti-note Summary:

- Berry growth
- Sugar accumulation
- Acid depletion
- Aroma development
- Phenolics
- Nitrogenous compounds
- Cell walls

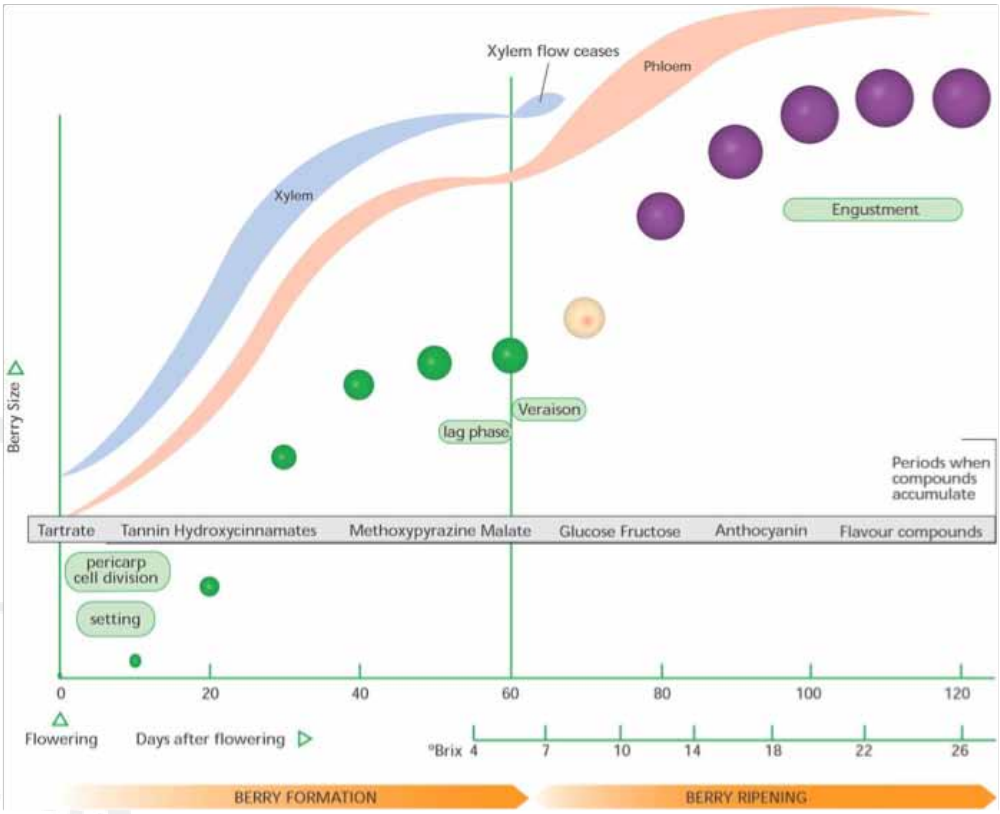

Figure 1. Detailed schematic of berry development. (Illustration by Jordan Koutroumanidis and provided by Don Neel: Practical Winery and Vineyard)

Veraison marks the beginning of what is known as phase 3, the period of rapid cell expansion and sugar accumulation. Potassium, amino acids and phenolic compounds increase, malic acid is degraded, and most flavours are developed.

This is the stage at which berries mature and are harvested for winemaking purposes. Its onset is highly dependent on the successful completion of the previous two phases.

Berry growth

Cell expansion proceeds at a high rate and berries increase in size during Phase 3, but this is strongly dependent on sugar and water availability.

Sugar accumulation

Hormones activate the relevant genes and these synthesize the enzymes for sugar import into the berry. Generally, sugar accumulation is more rapid in the weeks following veraison and usually becomes slower later.

In Australia, sugar accumulation is often considered too rapid relative to phenolic and aroma development. This is likely due to the high evaporative loss of water from berry surfaces under the dry conditions

experienced in many grapegrowing regions (grape skins are not 100% water-tight). This may have implications for management of some diseases such as the fungus Botrytis whose growth is favoured by sugar accumulation in berries.

Acid depletion

During this phase, berries cannot derive energy for metabolic processes from sugars. Instead, for most requirements, malic acid in the berry is drawn upon and broken down to provide energy.

During hot night time conditions, malic acid is further depleted by the respiratory process. Above 35^{0}C, tartaric acid provides the energy source.

When the energy needs of berries are low, that is, when temperatures are either very high or very low so that metabolic processes are minimised, some malic acid is transformed to sugar rather than being broken down to release energy. This maintains the pH inside cells and generally accounts for about 5% of sugar accumulation in berries. The presence of abscisic acid (ABA) in berries increases this activity resulting in a faster ripening process.

Aroma development

The methoxypyrazines responsible for the capsicum/asparagus aromas of some wines decrease as berries mature.

Conversely, the terpenoids which give floral or citrus aromas, increase. The production of some terpenoids post-veraison is related to the sugar content of berries: however, their final concentration will vary according to the interaction between rates of production and degradation of these compounds.

Phenolics

Anthocyanins begin to accumulate in the skins of red varieties about two weeks before the colour is visible.

In red varieties the levels of tannins in grape skins are already relatively high at veraison and remain essentially constant thereafter.

In white grapes, phenolic compounds diminish to minimal concentrations as berries mature.

Anthocyanins are an end product of sugar metabolism, but require only a minimum amount of sugar to develop, so that their accumulation is independent of the sugar content of berries. Tannins evolve over time, and their concentrations in berries are more independent of climatic conditions than for anthocyanins. The ability to extract seed tannins decreases after veraison.

Nitrogenous compounds

Nitrogen comes in a number of chemical forms and is an essential component of amino acids which are the building blocks for the more complex proteins that often act as hormones and enzymes in metabolic processes in the vine.

During Phase 3 of berry development, 80% of the nitrogen in berries is in the skins and seeds, while the juice contains barely 20% of the total berry nitrogen. Over the period of maturation, the ammonium concentration in berries decreases after veraison and the protein fraction increases, as ammonium is gradually incorporated into more complex compounds within the berry. The protein fraction is very small, however, with most nitrogen occurring as amino acids - at maturity 50-90% of the total nitrogen in grape juice exists as a component of amino acids. The soluble protein concentration in the berry reaches a maximum before maturation and then decreases. The concentration of proteins in grape juice at harvest can vary between 1.5-100 mg/L.

The amount of amino acids and proteins formed is, to some extent, characteristic of the variety and environmental influences. Generally, however, a small number of amino acids predominate. Many amino acids can be transformed to fulfil a need by the vine, e.g. for stress management due to drought conditions. This is of use to the vine, but some of these proteins such as the ‘defence’ proteins can be problematic. These ‘defence’ proteins can survive the winemaking process and increase the potential formation of wine haze. Additionally a high concentration of the amino acid arginine may produce ethyl carbamate (a carcinogen) in wine. Some amino acids can be transformed to malic acid and into sugars to provide energy for the berry if required.

Cell walls

The maturation process of berries is accompanied by a gradual ‘weakening’ of berry cell walls.

Pectin, a compound which acts to strengthen the rigid cellulose walls which characterise all higher plants, is gradually dissolved as berries ripen. The rate of degradation is further exacerbated if the vine has access to high levels of potassium, which moves readily into berries and compounds this process. These more fragile cell walls increase the berry’s susceptibility to attack by bunch rotting fungi such as Botrytis.

High potassium levels in juice can be a factor of the type of rootstock, or result from shading in the canopy. Potassium affects quality of red wine by increasing pH and impacting on anthocyanin development.

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Further information

Useful references:

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